ALADDIN2: a launchpad for the GENIE Earth-System Model

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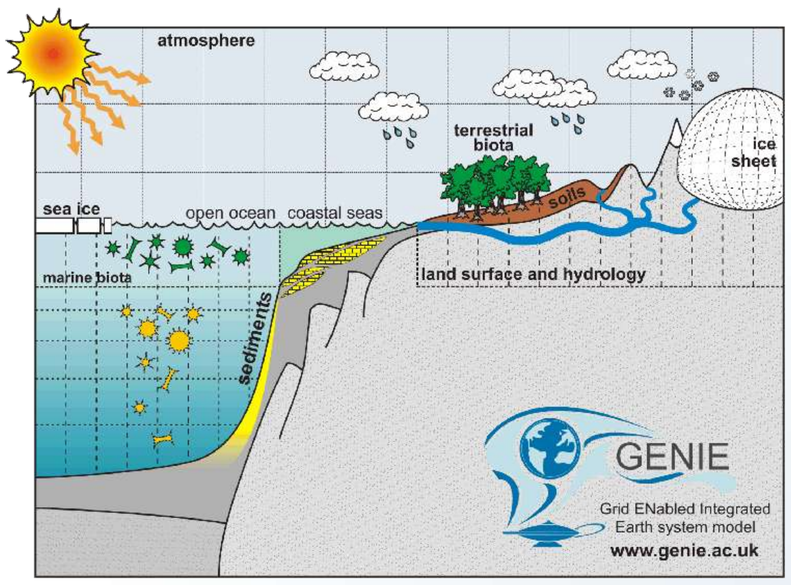

Figure 1. GENIE domain. GENIE models ocean, atmosphere and sea-ice physics, terrestrial and marine biogeochemistry and carbon cycling, rock weathering and sedimentation. As a community model its features and abilities are continuously developing.

GENIE (Grid-Enabled Integrated Earth-system model)

GENIE is a leading UK Earth-system modelling framework developed under the NERC-funded 'GENIE' and 'GENIEfy' projects, covering the domains shown in Figure 1. It is a modularised model (Figure 2), allowing simple coupling of e.g. different atmosphere or ocean schemes. With a coupled carbon cycle and simple 2-D atmosphere it will run at over 2000 model years per hour on an HPC (High-performance computing) node: facilitating long-timescale (up to millions of years) experiments not possible with a traditional climate model. In combination with the **GENIELab** software, massive ensemble 'grand challenge' experiments and multi-objective tuning exercises are made possible by harnessing the computational power of remote HPC resources.

ENGAGING with potential users

ENGAGE funding has been provided to support the development of a GENIE launchpad. Whilst a powerful and mature Earth-system model, GENIE has a high barrier to uptake due to i) the complexity of the sizeable codebase ii) the requirement for users to be familiar with the command line interface, shell scripting, XML, and data visualisation software. **ALADDIN2** will allow GENIE to harness the sizeable potential user-base of researchers with little technical computing expertise who may wish to perform experiments where no scientific development work is necessary but where currently a substantial technical expertise is required to run the model e.g. using a traceable tagged release of the model. **ALADDIN2** will also provide non-technical access to the model to students, policy-makers and members of the public in standalone executable format.

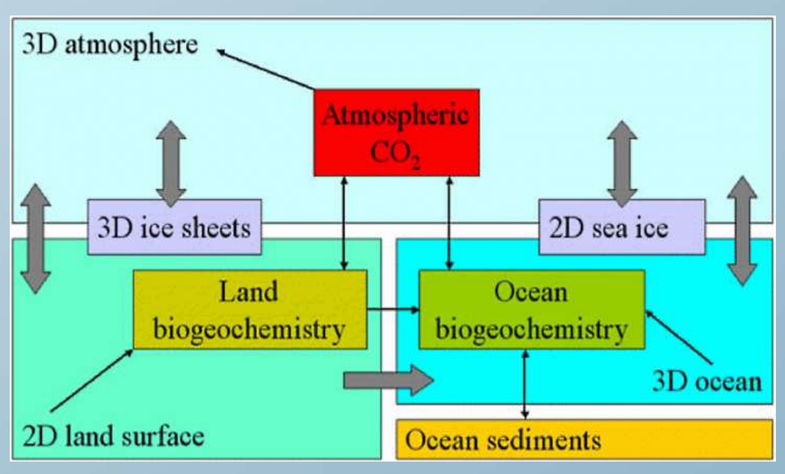

Figure 2. Modular GENIE. Schematic demonstrating the modular nature of GENIE, where any of the above components can be replaced by alternatives. e.g. 2-D atmosphere or 2-D ocean, alternative land or sea-ice schemes, with standardised physical and chemical/tracer couplings.

ALADDIN2 Summary

ALADDIN2 is an ENGAGE-funded project to develop a launchpad for the GENIE Earth-system model, which will allow interactive configuration and execution of GENIE and provide real-time visualisation of key model output. It will lower the barrier to uptake of GENIE for researchers by increasing ease of use and also provide access to the model for students and teachers, policy-makers and the public. It will run with the GENIE source-code as a fully-functional and configurable research tool, including the ability to 'export' pre-configured standalone instances as teaching / demo tools to define and launch ensemble experiments on remote computing resources.

Design philosophy

GENIE is a community model, having developed ad-hoc from a series of discrete models of Earth-system components. As such, whilst a popular and continually evolving tool, the development of GENIE's user interface has lagged behind. **ALADDIN2** should run the model without requiring modification to the GENIE codebase, and as far as possible to be future-proof against forthcoming developments to model/ framework code. To maximise accessibility, **ALADDIN2** must be cross-platform and it is thus being implemented in Java.

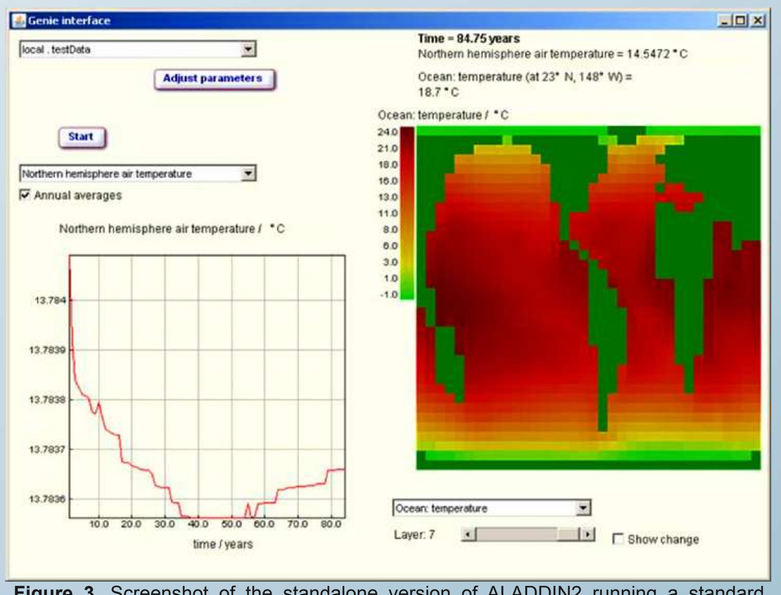

Figure 3. Screenshot of the standalone version of ALADDIN2 running a standard ocean physics experiment.

Implementation

ALADDIN2 has begun as two separate but convergent development strands, evolving from two existing softwares: the **Climate Simulator**, built by The Open University as a standalone teaching tool, using a customised version of GENIE and with limited configurability and functionality; and **ALADDIN**, a MatLab toolbox built as part of the GENIEfy project, which allows the configuration, compilation and launch of GENIE runs through a GUI. Key to the successful realisation of the launchpad is an extension to GENIE's XML configuration scheme which allows users to easily describe a simplified subset of configurable options and specify parameter ranges for ensemble experiments and tuning exercises.

The OU Climate Simulator has been ported to Java and is now operational with pre-compiled executables based on the development version of GENIE. It reads a GENIE XML config file (which describes e.g. the settings for an undergraduate tutorial session), determining which parameters are exposed for configuration (and the range of possible values) as well as assigning non-default, non-configurable parameter settings for the model runs. End-users can then launch the model and watch results in real time (Figure 3 and laptop demo).

Much of the GUI and XML-parsing code for this 'teaching tool' feeds into the development of the fully functional research launchpad, which will reproduce the functionality of ALADDIN and GENIELab (see below) as well as integrating the real-time visualisation capability of the Climate Simulator.

Implementation (continued)

The research launchpad (Figure 4,5) will facilitate component model selection, full parameter configuration including selection of parameter value ranges for ensemble experiments / tuning exercises and compilation and execution of single or multiple runs locally or remotely on Globus-capable HPC facilities.

ALADDIN2 will ship with the publicly available (though not yet released under an open-source license) GENIE source code. It is intended that, when complete, the research launchpad will be used to design and compile pre-configured standalone executable instances of **ALADDIN2** for teaching and demonstration purposes, performing the role currently filled by the ported Climate Simulator.

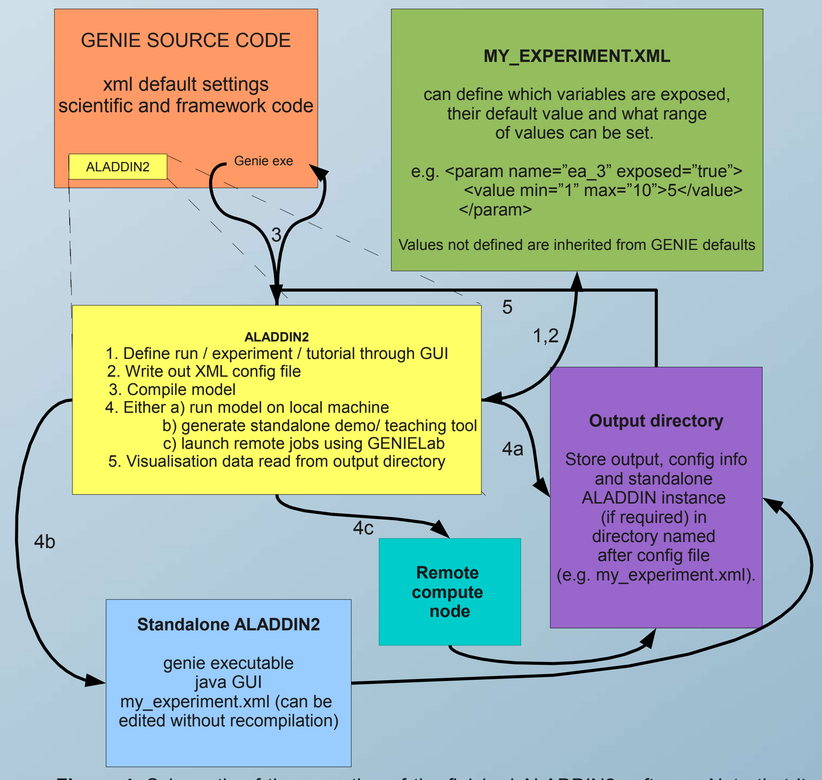

Figure 4. Schematic of the operation of the finished ALADDIN2 software. Note that it will operate from within the GENIE source, allowing it to control model compilation and export of standalone teaching / demonstration executables.

Integration with GENIELab

During the GENIE and GENIEfy projects, software was developed to provide the capability to execute and manage GENIE runs on the Grid. The resulting GENIELab software was built upon the GEODISE Compute and Database toolboxes for Matlab and Jython. Since much of this code is already written in Java and exploits the functionality of the Java Commodity Grid Kit (CoG) the only migration required will be porting of the scripted logic used in the Matlab environment. ALADDIN2 will support researchers in managing large ensembles of model runs across the National Grid Service and Condor pools (Figure 5). Later versions of the tool will add an interface to the GENIE data management system to provide convenient long-term archival capability for the output data.

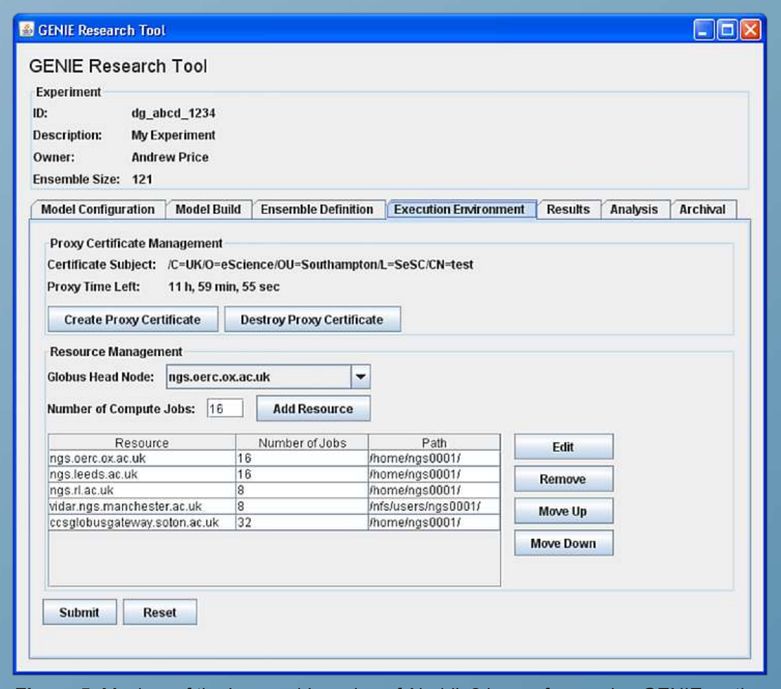

Figure 5. Mockup of the 'research' version of Aladdin2 in use for running GENIE on the National Grid Service / Condor pools.